FORM PTO 1390 (REV 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		MCNT 202
		U.S. APPLICATION NO (If known, see 37 CFR 1 5) 10/048237
INTERNATIONAL APPLICATION NO. PCT/GB00/02828	INTERNATIONAL FILING DATES 21/07/2000 (6 July 2000)	PRIORITY DATE CLAIMED 24/07/1999 (8 July 1999)

TITLE OF INVENTION DIRECT TYRE RETREADING

APPLICANT(S) FOR DO/EO/US Philip Kenneth FREAKLEY

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing 35 U.S.C. 371
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371 (f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371 (c)(2))
   a. [X] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information: PTO FORM 1449 (IDS) and copies of cited references
    PCT/ISA/220 (International Search Report or the Declaration)
    PCT/IB/304; PCT/IB/308; PCT/IB/332; PCT/IPEA/402; PCT/IPEA/416

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/048237 PCT/GB00/02828	21/07/2000 (21 July 2000)	24/07/2000 (08 July 1999)

21. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) – (5)):

		CALCULATIONS PTO USE ONLY
[ ]	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO And International Search Report not prepared by the EPO or JPO $1040.00	
[X]	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00	
[ ]	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $740.00	
[ ]	International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00	
[ ]	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00	

ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00	
Surcharge of $ 130.00 for furnishing the oath or declaration later than [ ] 20 [x] 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$ 130.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	17 - =	0	x 18/9	$ 0	
Independent claims	2 - =	0	x 84/42	$ 0	
MULTIPLE DEPENDENT CLAIM(s) (if applicable)			+ 280/140	$	
TOTAL OF ABOVE CALCULATIONS =				$ 1020.00	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.				$	
SUBTOTAL =				$ 1020.00	
Processing fee of $ _____ for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				$ 0	
TOTAL NATIONAL FEE =				$ 1020.00	
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). Assignment must be accompanied by appropriate cover sheet (37 CFR 3.28, 3.31) + (per property).				$	
TOTAL FEES ENCLOSED =				$ 1020.00	
				Amount to be Refunded:	$
				Charged:	$

a. [X] A check in the amount of $ 1020.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required or credit any overpayment to my Deposit Account No. 500624. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

David Rubin, Esq.

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David Rubin
Name

David T Rubin January 23, 2002
Signature Date

40,314
REGISTRATION NUMBER

MCNT 202

IN THE UNITED STATES OFFICE PATENT AND TRADEMARK

Applicants	:	Phillip Kenneth FREAKLEY et al.
Serial No.	:	To Be Assigned
Filed	:	Concurrently Herewith
Based on Intern. App. No.	:	PCT/GB00/02828
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Priority Document	:	9917364.3
Priority Date	:	24 July 1999 (24.07.1999)
For	:	DIRECT TYRE RETREADING

January 23, 2002

Honorable Commissioner of Patents
and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

In advance of prosecution, please amend the above-identified patent application as follows:

IN THE CLAIMS:

Enclosed is a separate sheet of the marked up claims as amended.

Please amend the claims as follows:

3. (Amended) A method according to claim 1, the article being a tyre casing.

4. (Amended) A method according to claim 1, the flowable material being a rubber or thermoplastic in the melt state or a thermosetting resin in the melt state or a particulate material.

5. (Amended) A method according to claim 1, the at least one inlet channel having a reduced cross-section at the point at which material enters the moulding cavity.

6. (Amended) A method according to claim 1, said material inlet comprising a plurality of radially disposed inlet channels.

7. (Amended) A method according to claim 1, said material inlet having at least one inlet channel defining a substantially continuous inlet channel around the whole of said material inlet.

9. (Amended) A method according to claim 1, the rate of flow of material into the moulding cavity being varied.

11. (Amended) A method according to claim 1, filling being stopped when the level of pressure upon the flowable material reaches a predetermined level.

12. (Amended) A method according to claim 1, the material inlet forming a side of the moulding cavity.

16. (Amended) An apparatus according to claim 14, the material inlet additionally comprising a material injection system.

REMARKS

An early and favorable response is earnestly solicited.

No fee is believed to be due, however, should a fee become due the Commissioner is hereby authorized to deduct any fee associated with this filing from Deposit Account No. 500624.

Respectfully submitted,

FULBRIGHT & JAWORSKI L.L.P.

By______________________________

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MARKED-UP CLAIMS AS AMENDED

Please amend the claims as follows:

3. (Amended) A method according to claim[s] 1 [or 2], the article being a tyre casing.

4. (Amended) A method according to [any one of the preceding claims] claim 1, the flowable material being a rubber or thermoplastic in the melt state or a thermosetting resin in the melt state or a particulate material.

5. (Amended) A method according to [any one of the preceding claims] claim 1, the at least one inlet channel having a reduced cross-section at the point at which material enters the moulding cavity.

6. (Amended) A method according to [any one of the preceding claims] claim 1, said material inlet comprising a plurality of radially disposed inlet channels.

7. (Amended) A method according to [any one of] claim[s] 1[-5], said material inlet having at least one inlet channel defining a substantially continuous inlet channel around the whole of said material inlet.

9. (Amended) A method according to [any one of the preceding claims] claim 1, the rate of flow of material into the moulding cavity being varied.

11. (Amended) A method according to [any one of the preceding claims] claim 1, filling being stopped when the level of pressure upon the flowable material reaches a predetermined level.

12. (Amended) A method according to [any one of the preceding claims] claim 1, the material inlet forming a side of the moulding cavity.

16. (Amended) An apparatus [Apparatus] according to [either one of] claim[s] 14 [or 15], the material inlet additionally comprising a material injection system.

WO 01/07243

PCT/GB00/02828

DIRECT TYRE RETREADING

The present invention is concerned with apparatus and methods of forming on a surface of an article a moulding from flowable material, and particularly for effecting a retreading of a tyre directly on a tyre casing.

Various methods of tyre retreading are known. Two particularly widely used techniques are Cold Capping and Hot Capping. In cold capping a precured (i.e. vulcanised) tread having a surface pattern is applied to a prepared tyre casing (i.e. a tyre which has been machined down to a predetermined size and any irregularities, e.g. pits or hollows, repaired) with a layer of uncured cushioning rubber separating the two. The arrangement of tyre tread, rubber cushioning and tyre casing held together in a tyre press is then autoclaved, curing (i.e. vulcanising/cross-linking) the cushioning rubber and bonding the tyre casing and tread. In hot capping a tread (having no surface pattern) is extruded (i.e. is un-cured), is applied to a prepared tyre casing and the tyre casing and tread is then moulded in a heated tyre press to form a tread pattern and to cure the tread, bonding it to the tyre casing.

Each technique has its advantages and disadvantages - cold capping enables a retreader to minimise capital investment by purchasing precured treads from suppliers, whereas hot capping requires greater capital investment but reduces the cost of consumables by not requiring the purchase of precured treads.

In both cases the predominant process cost is the time taken to heat the rubber in a tyre press to effect curing, which effectively determines the number of tyres which can be retreaded per tyre press per hour - heat must be conducted through a rubber layer about 20 mm thick to raise the temperature (typically from less than 80 °C) to about 160 °C, which is a slow process since rubber is an extremely good insulator.

This means that a typical curing time (for either process) is 60-90 minutes.

Retreading effected by moulding directly onto the surface of a tyre casing is known from e.g. US 4583928 and US 4139592, neither of which appears to have been commercially developed. Each of these requires the use of separate injection points in the crown (i.e. the equatorial plane) of the tyre tread mould. Effecting injection in the crown of the mould can be difficult and may require expensive machinery. Use of such methods may be achieved by e.g. sequential injection into each injection point (as opposed to simultaneous injection). This however would typically require a potentially time-consuming indexing of the tyre in order that injection points are presented in turn to an injection machine nozzle. This would also provide the potential for the formation of weak interfaces between the individually injected volumes of rubber. The provision of machinery for the simultaneous injection of rubber into the mould from crown injection points may be particularly expensive to achieve and operate. In particular, US 4583928 requires that a series of arcuate sections of a tyre casing have mouldings formed on them, one after the other, each moulding being cured before the next is made. This is particularly slow and provides a series of potentially weak weld lines. US 4139592 allows for the simultaneous use of a series of injectin ports locates across the equatorial plane of a moulding cavity to form a tread on a tyre casing. The specific positioning (on the equatorial plane) of the injection ports and their relative position forms an essential element of the invention, preventing the formation of weak weld lines. Curing advantageously takes place while the tyre is still in the injection mould (column 6 lines 20-27).

The present invention overcomes the prior art disadvantages, allowing for tread formation directly on a tyre casing, reducing the effort required in preparing tyre casings, and reducing the time required for curing. Advantageously, curing can take place separately from the tread forming apparatus (below), allowing optimum usage of the tread forming apparatus and helping to reduce the capital investment per tyre

retreaded per hour. As well as forming treads directly on tyre casings, treads can be formed on mould assemblies, allowing for the advantages of the separate curing step (above). The treads can subsequently be removal from the mould assemblies and used for cold or hot capping.

According to the present invention there is provided a method of forming on a surface of an article a moulding from flowable material comprising the steps of:

i) Contacting the surface with a mobile mould matrix and material inlet having (i.e. defining) at least one inlet channel to form a moulding cavity defining a first volume, the material inlet being displaceable relative to the surface and the mobile mould matrix;

ii) Filling the moulding cavity via the at least one inlet channel of the material inlet with flowable material;

iii) Stopping filling and displacing the material inlet relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the material inlet into the moulding cavity being severed;

iv) Contacting the exposed flowable material, the mobile mould matrix and the surface with a forming member to form a moulding cavity defining a second volume; and

v) Curing the flowable material to complete the moulding.

The material inlet and forming member may define a side wall of the moulding cavity. In the case of cylindrical or toroidal articles, this would not be an equatorial plane such as a tyre surface.

The filling of the mould cavity of step (ii) may be effected simultaneously about the circumference (i.e. the perimeter) of the article. The provision of simultaneous injection minimises the potential for formation of weak interfaces. Forming is completed by step (iv). In the embodiments of the invention below, pressures in the mould cavity are predicted to reach a maximum of 8 MPa (80 bar) and therefore a rigid support structure for the apparatus defining the mould cavity is necessary, preferably a segmented one in order to enable easy removal.

As discussed above, the curing of flowable materials such as rubber can be a slow and time-consuming process which significantly affects the economics of a manufacturing process. By displacing the material inlet from the mobile mould matrix and the surface and replacing it with a forming member, the material inlet (and the system which supplies flowable material to it) is free to be used in another moulding process whilst curing takes place. Since the material inlet and the material supply system connected to it comprise typically the most expensive part of the apparatus used in the moulding process, this can lead to a very substantial reduction in the cost of apparatus required per moulding produced per hour. It also means that as soon as the moulding cavity has been filled and the material inlet replaced by the forming member, the flowable material can be cured, avoiding unnecessary cooling.

Displacement of the material inlet relative to the mobile mould matrix causes a break in the flowable material linking them. This may be aided by the use of a cutting tool. The exposed flowable material of step (iii) may be manipulated prior to contacting it with the forming member. For example, exposed rubber could be rolled down to contact an exposed surface of a tyre casing.

The article on whose surface the moulding is to be formed may be of any desired shape, and similarly the mobile mould matrix, material inlet and forming member may be appropriately shaped.

The invention, however, is particularly useful in forming mouldings as annular layers on toroidal or cylindrical cores. In particular, the invention may be used for moulding tyre treads onto tyre casings.

The flowable material may be any material which can be made to flow into the moulding cavity, for example materials such as rubbers or thermoplastics in the melt state, thermosetting resins such as polyurethane in the melt state, or particulate materials which are able to flow. Clearly, when the material inlet is displaced the flowable material at the inlet should be in a sufficiently viscous state to prevent its escape.

By forming the moulding directly onto the surface of the article (e.g. a tyre casing) rather than producing the moulding separately and then attaching it to the surface of the article by curing (e.g. hot capping or cold capping), the overall process time can be reduced significantly, although of course a subsequent capping step may be employed where necessary. The separation of the curing step from the moulding step means that a number of mouldings can be simultaneously cured.

The at least one inlet channel of the material inlet may be shaped so that at the point at which material enters the moulding cavity, it has a reduced cross-section. This causes the rate of flow per unit area to be greater than that in the rest of the material inlet, increasing pressure temporarily, generating deformation energy and heating the flowable material as it enters the moulding cavity. Prior to the reduced cross-section area of the inlet channel, the pressure drop and temperature increase is small, minimising the danger of premature corsslinking and permitting pauses in manufacture without cleaning down of the apparatus being necessary. This forms a further aspect of the present invention. Thus according to the present invention there is also provided injection moulding apparatus for flowable settable material in which work done on the flowable material causes its temperature to be elevated sufficiently to set it (i.e. cure it). The work done on the flowable material may be by injection force against flow resistance.

The material inlet may comprise a plurality of radially disposed inlet channels. Alternatively, it may comprise at least one inlet channel defining a substantially continuous inlet channel around the whole of said material inlet. For example, there may be a single continuous inlet channel about the whole of the material inlet. This provision of a single inlet channel provides a number of substantial advantages over the prior art devices. In particular it provides for:

i) a short flow path for mould filling;

ii) filling in a single sweep, avoiding air entrapment;

iii) complete avoidance of potentially weak flow interfaces such as occurs when several injection points and long flow paths are used; and

iv) a balanced radial force on the casing during filling, minimising distortion problems.

The elevated temperature of the flowable material at the start of the curing process results in a shorter curing process time and may additionally improve the performance and wear life of the moulding (e.g. tyre tread) - high temperatures are conducive to oxidative degradation and so the longer that the surface layer of the moulding is held at a high temperature, the more oxidative degradation will occur, and *vice versa*.

The rate of flow of material through the material inlet may be varied as the moulding cavity is filled. For example, it may be reduced for the final material to enter the moulding cavity. This can be used to prevent excessive heating and curing (crosslinking) of residual material in the material inlet, particularly between cycles.

Rather than introduce a measured volume of material into the moulding cavity, a pressure sensor (e.g. transducer) or pressure switch may be used to determine

the pressure being placed upon the flowable material and to stop filling of the moulding cavity when a predetermined level of pressure is reached. This is particularly useful since it means that a variable volume of material may be introduced to the moulding cavity to fill it - in the case of tyre casings, this means that their surface need not be uniform and may e.g. contain pits or hollows. This tolerance of flaws in the surface of the tyre casing can reduce the cost of preparing a tyre casing for retreading and may also allow tyre casings to be retreaded which, due to surface deformation, would not be suitable for retreading using existing techniques such as hot or cold capping.

The material inlet may form a side of the moulding cavity. In the case of the article being a tyre casing, the material inlet may form a tyre-edge side of the moulding cavity.

Thus the material inlet may have e.g. an overall radial shape, allowing filling from all around an article such as a tyre casing. Since a tyre tread will have a patterned outer (circumferential) surface, this provides the advantage that displacing of the material inlet will not affect the patterned surface being formed.

Also provided according to the present invention are apparatus for forming on a surface of an article a moulding from flowable material, comprising a mobile mould matrix, material inlet and forming member, the material inlet being displaceable relative to the mobile mould matrix and the article.

The apparatus may additionally comprise at least one support member for the article - in the case of forming a tread on a tyre casing, the pressures required to form the moulding would cause deformation of the tyre casing and so the provision of a support member (or support members) prevents any deformation from occurring.

The material inlet may additionally comprise a material injection system, for example comprising a screw pre-plasticisation unit into which is fed the flowable material in the solid state, the plasticised flowable material being forced into an injection cylinder from where a hydraulic injection ram actuator exerts force on it, causing it to fill the moulding cavity. The injection cylinder may be heated.

It may be desirable to be able to use the material injection system to form a range of mouldings, e.g. different tyre treads on different sized tyre casings, using a range of mobile mould matrixs and material inlets. Thus the material inlet may be removably attached to the material injection system.

The forces required to cause the flowable material to fill the moulding cavity and to subsequently form the moulding may be quite substantial - in the case of retreading a tyre casing using a rubber, a maximum force of about 12 MPa, and an average force of about 4.5 MPa, has to be exerted upon the material. Thus the mobile mould matrix must be capable of withstanding such forces - each quadrant of a mobile mould matrix and forming member used to exert 4.4 MPa of pressure in forming a tyre tread on a tyre casing will have approximately 98 tonne of opening pressure force exerted upon it.

The mobile mould matrix may comprise a segmented mould which is joined together to define the inner shape of the mobile mould matrix, i.e. that which will define the moulding cavity. A retaining ring may be placed around the segmented mould and a cam or cams attached to allow it manipulation. A support assembly may also be used to provide mechanical support for the mobile mould matrix, particularly for holding the edge forming member in place and exerting sufficient force upon it.

Despite the teachings of the prior art such as US 4139582 which states that in order to successfully fill a moulding cavity defined about a tyre casing, injection of

rubber must be from the equatorial plane of the moudling cavity, the present inventors have now found that, surprisingly, injection of flowable materials into a tyre casing or other cylindrical or toroidal moulding cavity may be effected from the side of the moulding cavity. The inventors have found that this need not result in the formation of weak weld lines and thus the products of such moulding operations are mechanically sound.

Thus the present invention also provides a method of forming from flowable material a moulding on a surface of a toroidal or cylindrical article having at least one side wall, comprising the steps of:

i) contacting the surface with a mobile mould matrix having either one continuous inlet on the side wall or a plurality of discontinuous inlets along the length of the side wall, and simultaneously contacting the inlet or each of the inlets with an injection port, the mobile mould matrix and the injection ports defining a moulding cavity;

ii) filling the moulding cavity via the inlets with flowable material:

iii) stopping filling and displacing the injection port or each of the injection ports relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the injection port or injection ports into the moulding cavity being severed;

iv) sealing the inlet or each of the inlets; and

v) curing the flowable material to complete the moulding.

Such a toroidal or cylindrical article could be a tyre casing. The point of injection into the side wall could be anywhere on the side wall.

The invention will be further apparent from the following description, with reference to the several figures of the accompanying drawings, which show, by way of example only, one form of tyre retreading apparatus. Of the figures:

Figure 1 shows cross-sectional views of a mobile mould matrix, material inlet and article (tyre casing) whilst the moulding cavity is being filled ("fill step") (Figure 1a) and when the material inlet is displaced to sever the connection with the moulding cavity ("crop" step) (Figure 1b). Cross-hatched area (also in Figures 4 and 7) indicates the cross-section of circular inlet channel 131;

Figure 2 shows (Figures 2a and 2b) support members forming a support assembly for a tyre casing;

Figure 3 shows the tyre casing support assembly of Figure 2, the tyre casing being contacted by edge forming member and mobile mould matrix;

Figure 4 shows the arrangement of Figure 3, together with a material injection system, a datum/support for the apparatus, and an actuator for controlling filling and displacing the material inlet.

Figures 5 shows (Figures 5A-5C) an alternative material inlet arrangement in use;

Figure 6 shows (Figures 6A and 6B) another alternative material inlet arrangement, having material injection ports; and

Figure 7 shows the embodiment of Figures 5A-5C in use.

Example 1

In a first embodiment (Figures 1-4), moulding apparatus 10 for forming a moulding on the outer surface of tyre casing 20 from rubber 11 comprises support members 30, 31, 32, 33 (also labelled "A" in the Figures) and 40, 41, 42, 43 (also labelled "B" in the Figures) for tyre casing 20, support members 30-33, 40-43 being held in place by locking/mounting ring 50 (also labelled "C" in the Figures). Mobile mould matrix 60 comprises segmented mould 70 having heater elements 80, 81, 82, 83 and retaining ring 90 (also labelled "E" in the Figures) which holds segmented mould 70. Cams 100, 101 (also labelled "F" in the Figures) are attached to segmented mould 70 to manipulate it. Material inlet 110 comprises control ring 120 and circumferential inlet 130 having inlet channel 131. Mobile mould matrix 60, casing 20 and material inlet 110 together define moulding cavity 140 having a first volume. Similarly, mobile mould matrix 60 and heated forming member 230 together define moulding cavity 140 having a second volume. Inlet channel 131 has a reduced cross-sectional area at the point at which rubber 11 will enter moulding cavity 140. The first and second volumes of mould cavity 140 are equal.

Circumferential inlet 130 is removably attached to material injection system 150 which comprises pressure transducers 151, 152, injection cylinder 160 having heater 161, screw pre-plasticisation unit 170 and hydraulic injection ram actuator 180.

Support plate 190 acts as a datum for the apparatus as a whole, ensuring the correct positioning of material inlet 110 and mobile mould matrix 60. Control ring 120 is attached to actuator 200. Forming member 230 (also labelled "D" in the Figures) contacts mobile mould matrix 60 and has heater elements 220, 221.

In use, a tyre casing 20 is prepared for retreading by inserting support members 30-33 and then support members 40-43. Support members 30-33 widen as the radius increases, and support members 40-43 narrow as the radius increases giving tapered junctions between them. Locking/mounting ring 50 is then placed into the orifice defined by support members 30-33 and 40-43, locking them in position and providing means for subsequently mounting tyre casing 20. As can be seen from Figures 2a and 2b, support members 30-33 and 40-43 and locking/mounting ring 50 are arranged to redistribute radially acting forces in the circumferential direction. As can be seen from Figure 4, support members 30-33, 40-43 are arranged to redistribute forces mainly on the side of material inlet 110 where high forces are exerted. Tyre casing 20 is then contacted by mobile mould matrix 60, which is positioned by referencing locking/mounting ring 50 using cams 100, 101. The use of cams 100,101 in bringing together mobile mould matrix 60 and material injection system 150 results in the edge of inlet 130 contacting casing 20 and the force exerted being transmitted across casing 20 to press the edge of mould 70 against casing 20. Thus a positive sealing force is exerted against the rubber pressure without affecting any other aspect of the filling operation.

Whilst this is being done, material injection system 150 and inlet channel 131 are charged with rubber 11 ready for supply to moulding cavity 140 when it has been formed. Actuator 200 positions control ring 120 over inlet channel 131 to prevent escape of rubber 11, pre-plastication unit 170 is activated and rubber 11 in the solid state is fed into it. The deformation energy exerted upon solid rubber 11 is converted into heat, sufficient to change the rubber 11 into a plastic/melt state. As the material injection system 150 and inlet channel 131 fills with rubber 11, air is vented and injection ram actuator 180 exerts a small back pressure and is forced back (i.e. is retracted) by rubber 11. Once ram actuator 180 has been fully retracted and the pressure detected by transducers 151, 152 has reached a predetermined level, material injection system 150 and material inlet 131 are charged and ready to fill moulding cavity 140. Rubber 11 is kept in the plastic/melt state by heater 161.

The assembly of tyre casing 20 and mobile mould matrix 60 is then contacted with material inlet 110, control ring 120 being simultaneously retracted by actuator 200 and opening inlet channel 131, thus defining moulding cavity 140. Material inlet 110 is connected to material injection system 150, which also contacts locking/mounting ring 50 to ensure correct positioning of tyre casing 20 and mobile mould matrix 60 relative to material inlet 110.

Ram actuator 180 then forces rubber 11 out of material injection system 150, through inlet channel 131 and into moulding cavity 140. Flow resistance caused by the reduced cross-section part of inlet channel 131 causes deformation energy to be generated, heating rubber 11 as it enters moulding cavity 140. Heaters 80, 81, 82, 83 heat mobile mould matrix 60 and moulding cavity 140. Once ram actuator 180 has been extended by at least a first predetermined amount, meaning that about 0.5 litres of rubber is needed to complete filling, the rate of extension of ram actuator 180 is reduced in order to reduce the heating of the final rubber 11 to enter moulding cavity 140. Once ram actuator 180 has been extended by at least a second predetermined amount and transducers 151, 152 detect a pressure of at least a predetermined amount, moulding cavity 140 has been filled with rubber 11. Actuator 200 is then extended, causing control ring 120 to lift mobile mould matrix 60 away from circumferential inlet 130 and simultaneously closing inlet channel 131, severing the flow of rubber from material inlet 110 (i.e. circumferential inlet 130) into moulding cavity 140. Cams 100, 101 then displace material inlet 110 relative to mobile mould matrix 60 and the outer surface of tyre casing 20, leaving exposed rubber 11.

Inlet channel 131 and material injection system 150 may once again be charged with rubber 11.

Mobile mould matrix 60 and the outer surface of tyre casing 20 are then contacted with forming member 230 to form moulding cavity 140 defining a second volume and causing the exposed rubber 11 to contact the outer surface of tyre casing 20.

The rubber 11 is then cured by heating it using heaters 231, 232, 80-83. Forming (shaping) has already been completed.

Example 2

In a second embodiment (Figures 5A-5C, 7), a more robust and mechanically simpler apparatus is provided. The use of the apparatus is extemely similar to that of the previous embodiment. Notably, control ring 120, support plate 190 and actuator 200 do not form part of the second embodiment. Control ring 120 is replaced by an extended circumferential inlet 130, which additionally comprises high temperature thermoplastic seal 300. Heater 161 and transducers 151, 152 are not shown.

In use, the tyre casing 20 is prepared for retreading as before with support members 30-33, 40-43 and locking/mounting ring 50. Mobile mould matrix 60 is placed around casing 20. The inlet apparatus differs significantly from those of Figure 1, not having control ring 120 and related actuating and supporting means, simplifying the apparatus significantly. Inlet 130 is extended in size, obviating the need for control ring 120. Inlet 130 is also provided with high temperature thermoplastic seal 300 which is slightly deformable (without affecting the surface of the tyre tread to be formed) and ensures a sealing of mould cavity 140 whilst making the sealing a more mechanically tolerant process. The shoulder region dimensions of prepared tyre casings vary, and the seal arrangment of this embodiment enables the creation of sealed mould cavities 140 where there is such dimensional variance. Material inlet 110 and mobile mould matrix 60 are mounted on tyre casing 20 to define mould cavity 140. Mould cavity 140 is then filled as before with rubber 11 through circumferential inlet channel 131. Material inlet 110 is then displaced relative to casing 20 and mobile mould matrix 60 to leave exposed

flowable material, the rubber 11 connecting that attached to tyre casing 20 and that in inlet channel 131 simply tearing as it is stretched.

Mobile mould matrix 60 and the outer surface of tyre casing 20 are then contacted with forming member 230 to form moulding cavity 140 defining a second volume. In order to prevent deformation of rubber 11 resulting from expansion of volatiles in rubber 11 this should be done within two minutes (preferably less) from the removal of material inlet 110. The rubber 11 is then cured by heating it using heaters 231, 232, 80-83. Forming (shaping) has already been completed. Whilst this forming and curing step takes place, material inlet 110 can be used in a subsequent retreading process with a different tyre casing 20 and mobile mould matrix 60.

Example 3

In a third embodiment (Figures 6A-6B), rather than use a circumferential inlet channel 131, a series of 12 injection ports 401-412 are used to simultaneously inject rubber 11 into moulding cavity 140 through inlets 421-432. The method of operation is exactly the same as for Example 2, except that upon removel of intection ports 401-412 from inlets 421-432 of mobile mould matrix 60, inlets 421-432 are then filled with sealing plugs 441-452. Rubber 11 is then cured.

Inlet channel 131 actually comprises circular distribution channel 460 to which rubber 11 is fed from injection cylinder 100 by radial feed channels 461-464.

Sections 471,472,473,474 are blocked sections of circular distribution channel 460 which prevent the creation of regions of stagnation.

Positions 480 are regions of convergent flow where viscous heating is substantially uniform.

In an alternative embodiment, adjacent injection ports are paired up, each pair being fed by one of six radial feed channels 490.

It will be appreciated that it is not intended to limit the invention to the above example only, many variations, such as might readily occur to one skilled in the art, being possible, without departing from the scope thereof as defined by the appended claims.

CLAIMS

1. A method of forming on a surface of an article a moulding from flowable material comprising the steps of:

i) Contacting the surface with a mobile mould matrix and material inlet arrangement defining at least one inlet channel to form a moulding cavity, the material inlet arrangement being displaceable relative to the surface and the mobile mould matrix;

ii) Filling the moulding cavity via the at least one inlet channel of the material inlet arrangement with flowable material;

iii) Stopping filling and displacing the material inlet arrangement relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the material inlet arrangement into the moulding cavity being severed;

iv) Contacting the exposed flowable material, the mobile mould matrix and the surface with a forming member to form a moulding cavity; and

v) Curing the flowable material to complete the moulding.

2. A method according to claim 1, the surface of the article having a cylindrical or toroidal shape.

3. A method according to claims 1 or 2 the article being a tyre casing.

4. A method according to any one of the preceding claims, the flowable material being a rubber or thermoplastic in the melt state or a thermosetting resin in the melt state or a particulate material.

5. A method according to any one of the preceding claims, the at least one inlet channel having a reduced cross-section at the point at which material enters the moulding cavity.

6. A method according to any one of the preceding claims, said material inlet arrangement comprising a plurality of radially disposed inlet channels.

7. A method according to any one of claims 1-5, said material inlet arrangement defining at least one inlet channel defining a substantially continuous inlet channel around the whole of said material inlet arrangement.

8. A method according to claim 7, said material inlet arrangement defining a single continuous inlet channel about the whole of said material inlet arrangement.

9. A method according to any one of the preceding claims, the rate of flow of material into the moulding cavity being varied.

10. A method according to claim 9, the rate of flow of material into the moulding cavity being reduced prior to filling being stopped.

11. A method according to any one of the preceding claims, filling being stopped when the level of pressure upon the flowable material reaches a predetermined level.

12. A method according to any one of the preceding claims, the material inlet arrangement forming a side of the moulding cavity.

13. A method according to claim 12, the article being a tyre casing and the material inlet arrangement forming a tyre-edge side of the moulding.

14. Apparatus for forming on a surface of an article a moulding from flowable material, comprising a mobile mould matrix, material inlet arrangement defining at least one inlet channel and forming member, the material inlet arrangement being displaceable relative to the mobile mould matrix and the article, said mobile mould matrix and material inlet arrangement being contactable with the surface of said article to form a mould cavity which may be filled with said flowable material, said material inlet arrangement being displaceable relative to said surface and said mobile mould matrix, and said forming member being contactable with said mobile mould matrix and said surface to form a moulding cavity.

15. Apparatus according to claim 14 additionally comprising at least one support member for the article.

16. Apparatus according to either one of claims 14 or 15, the material inlet arrangement additionally comprising a material injection system.

17. A method of forming from flowable material a moulding on a surface of a toroidal or cylindrical article having at least one side wall, comprising the steps of:

i) contacting the surface with a mobile mould matrix and material inlet arrangement defining either one continuous inlet channel on the side wall or a plurality of discontinuous inlet channels along the length of the side wall, and simultaneously

contacting the inlet channel or each of the inlet channels with an injection port arrangement, the mobile mould matrix and the injection port arrangements defining a moulding cavity;

ii) filling the moulding cavity via the inlets with flowable material;

iii) stopping filling and displacing the injection port arrangement or each of the injection port arrangements relative to the mobile mould matrix and the surface to leave exposed flowable material, the flow of material from the injection port arrangement or injection port arrangements into the moulding cavity being severed;

iv) sealing the inlet channel or each of the inlet channels; and

v) curing the flowable material to complete the moulding.

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Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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(54) Title: DIRECT TYRE RETREADING

(57) Abstract: The present invention is concerned with apparatus and methods of forming on a surface of an article a moulding from flowable material, and particularly for effecting a retreading of a tyre directly on a tyre casing.

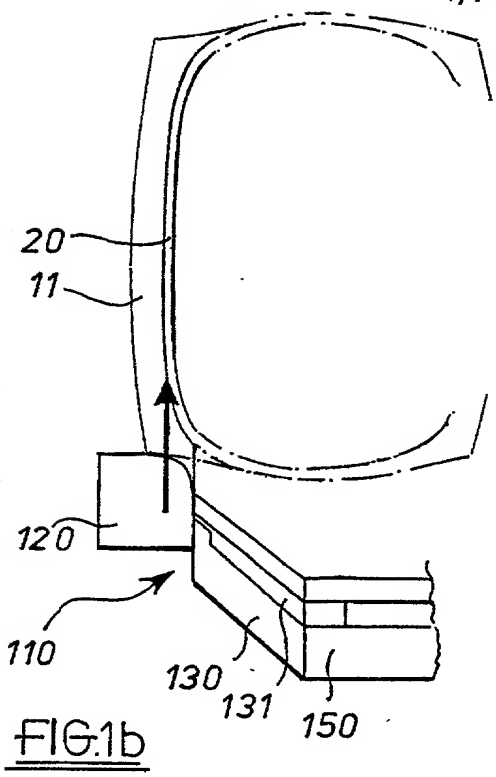


FIG.1b

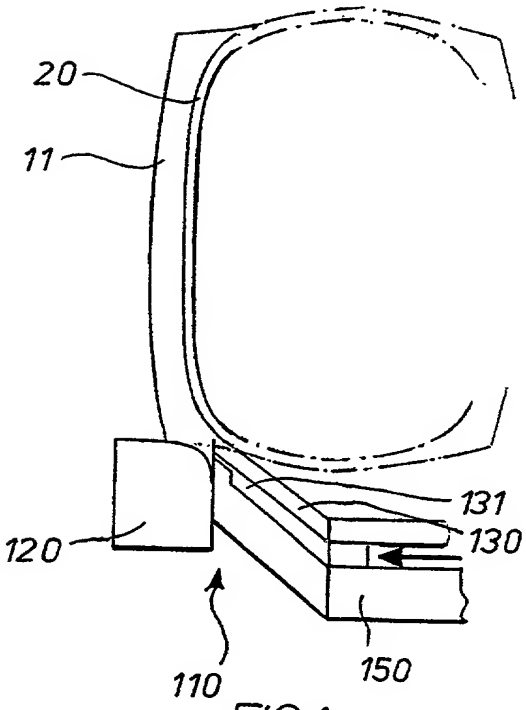


FIG.1a

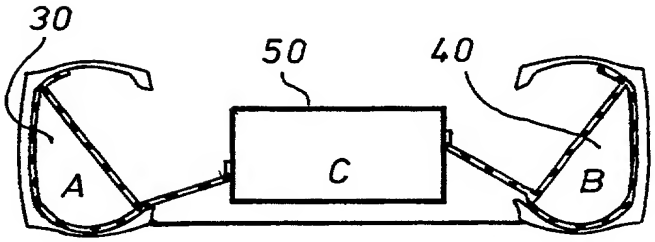


FIG. 2b

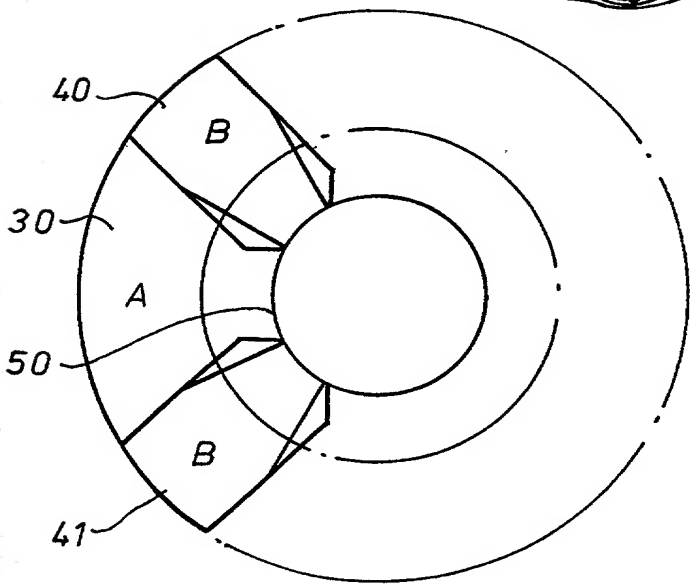


FIG.2a

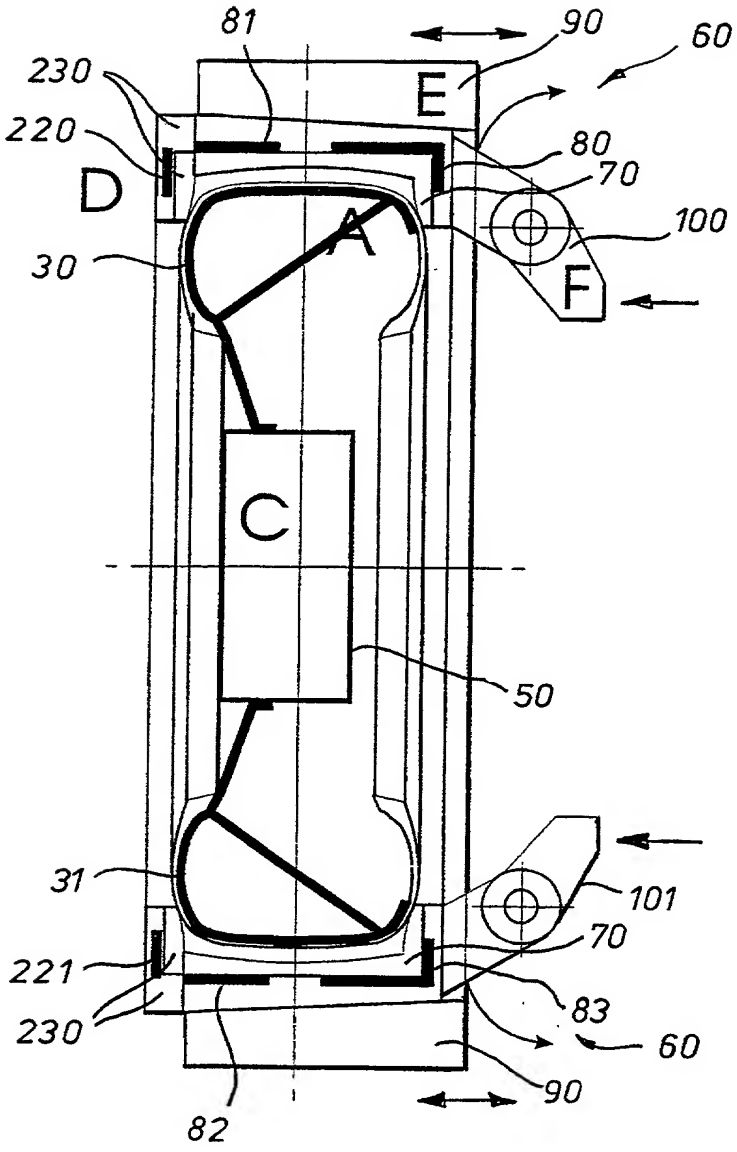
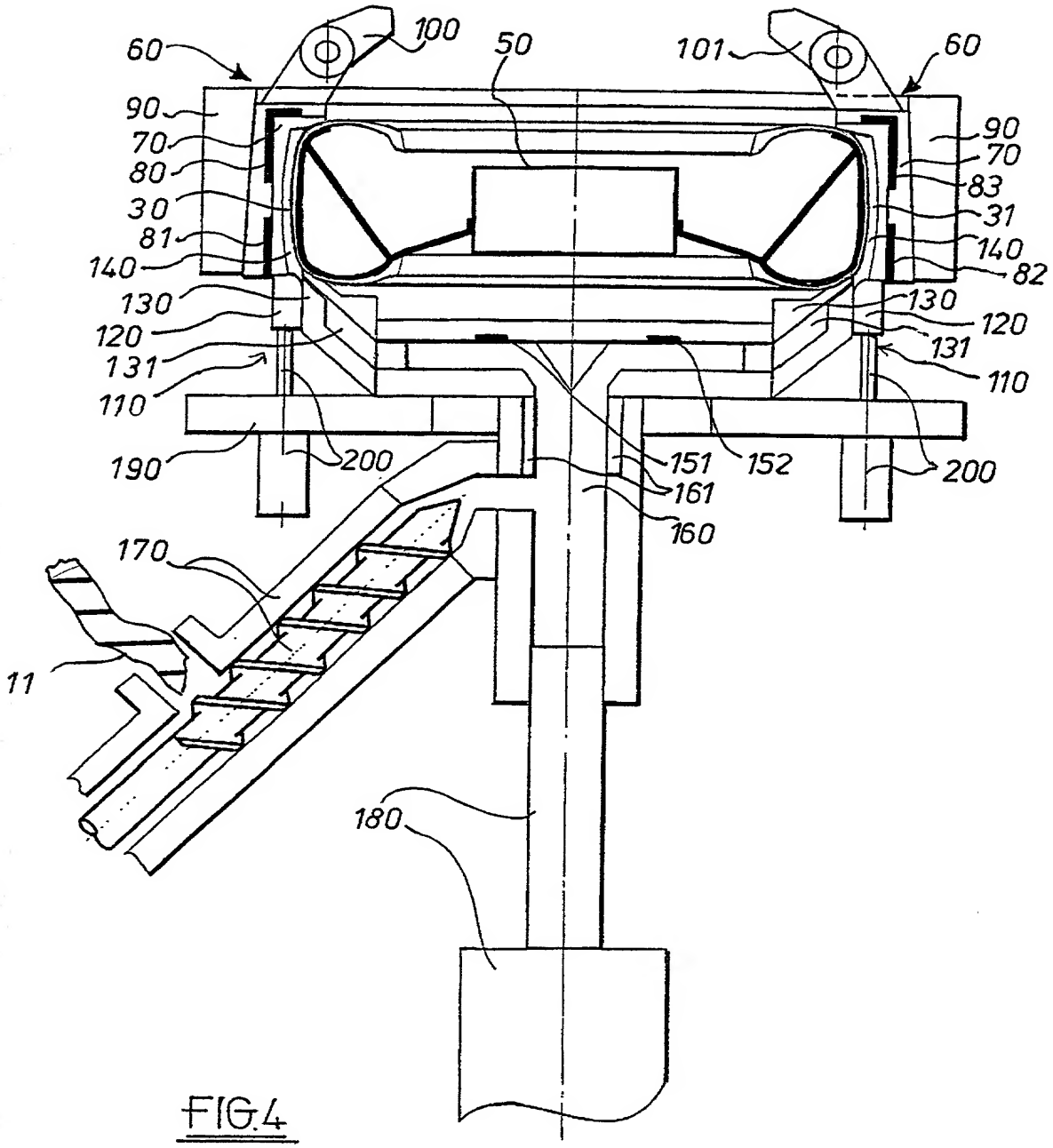


FIG.3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31
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120
131
110
170
11
180

FIG.4

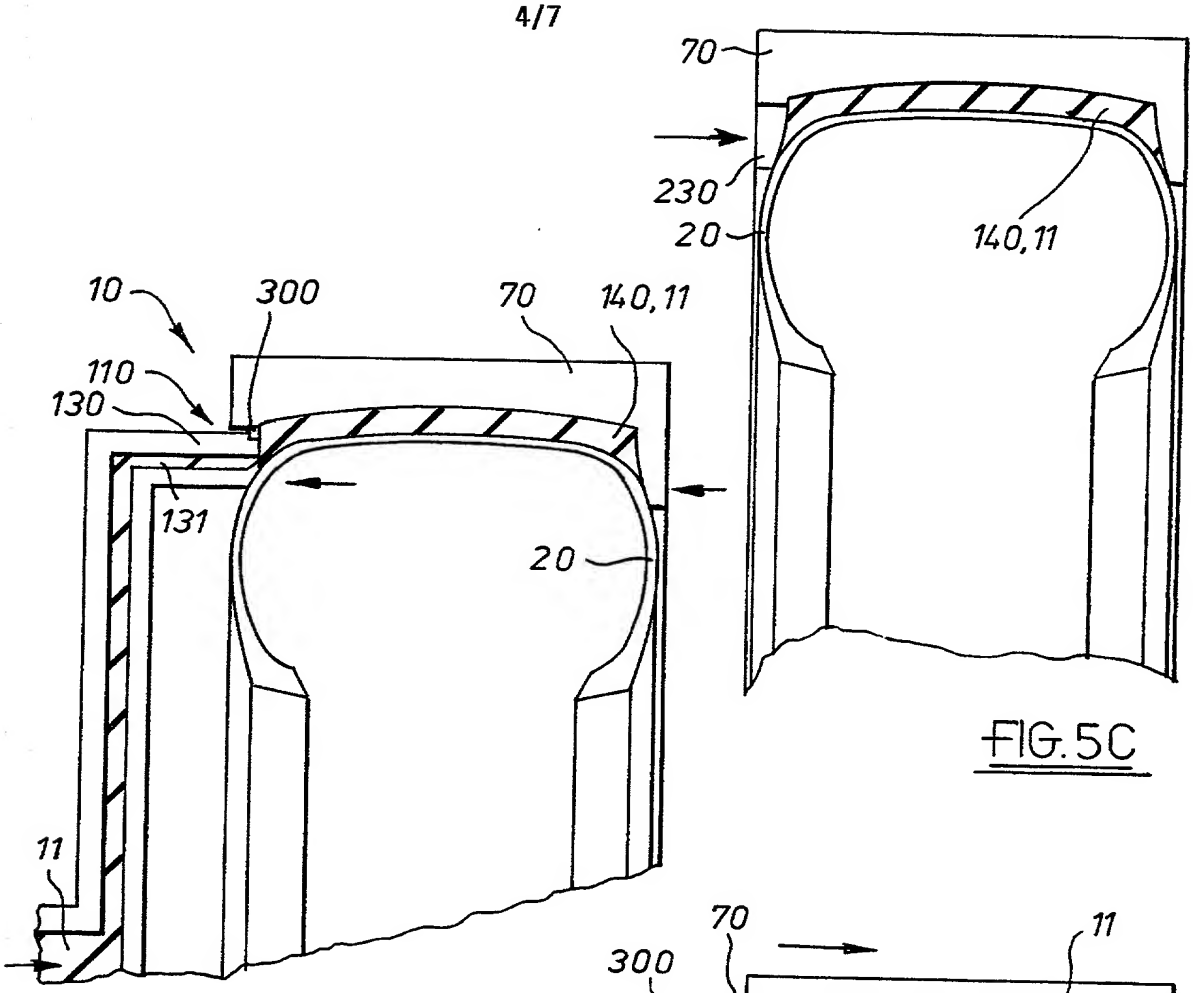

FIG. 5C

FIG. 5A

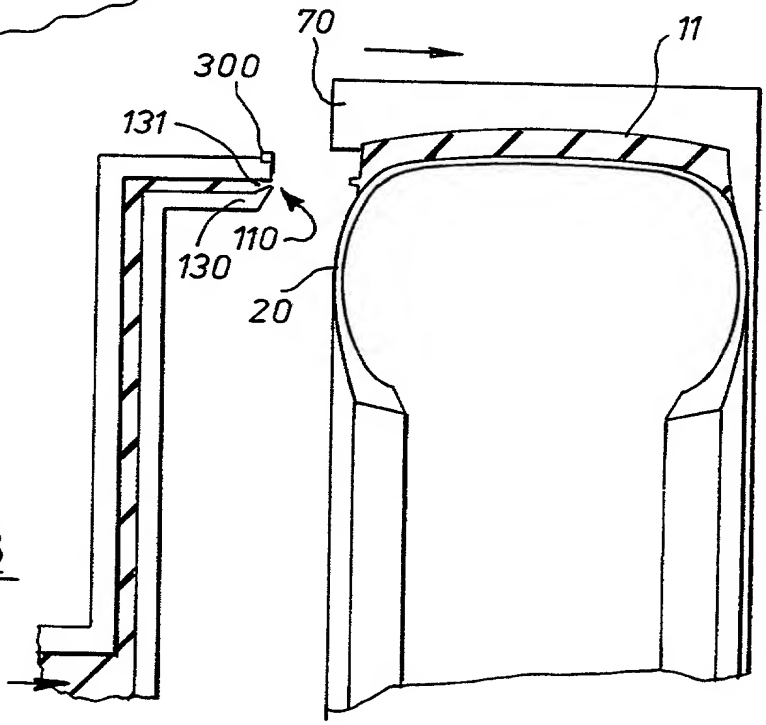

FIG. 5B

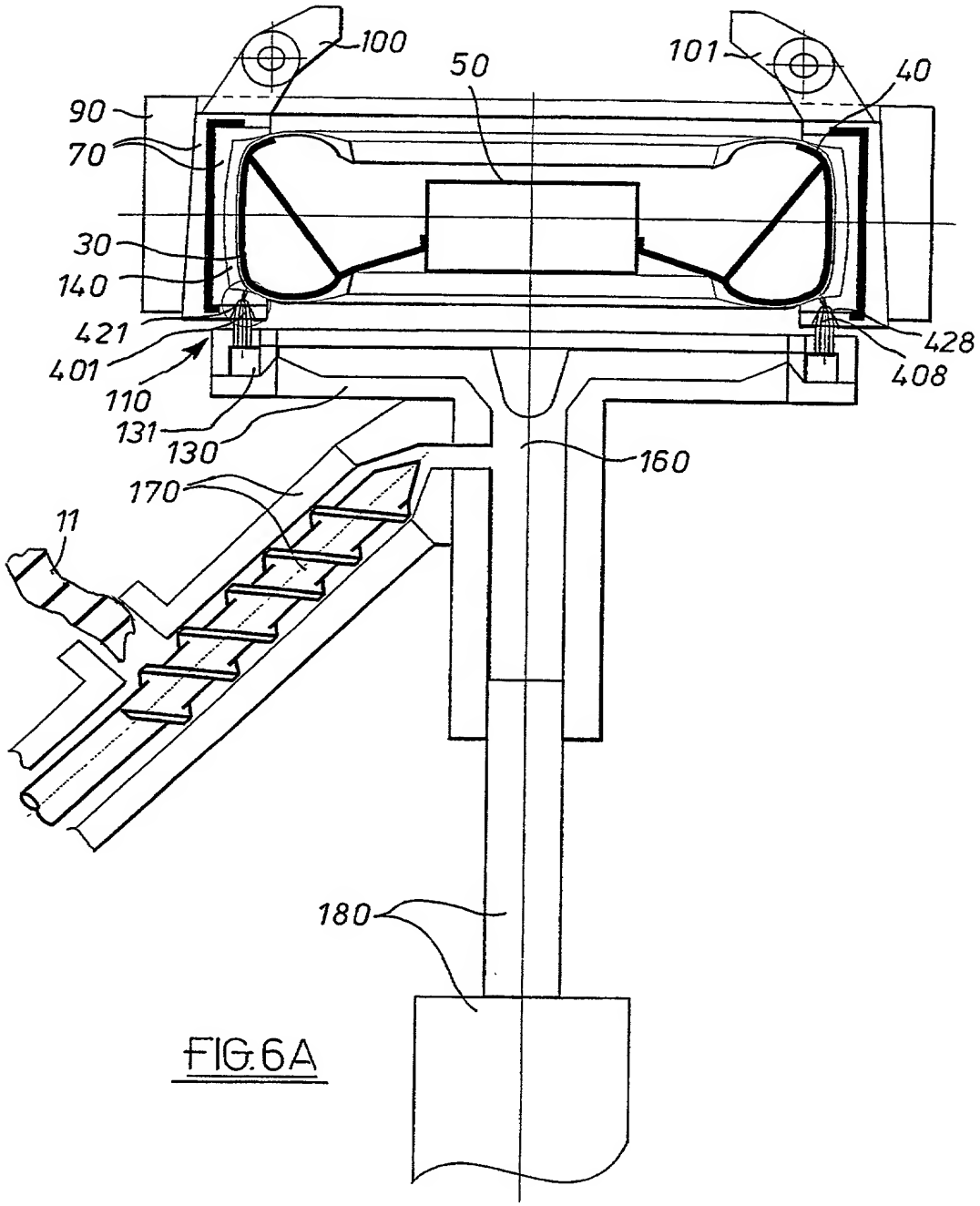
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FIG.6A

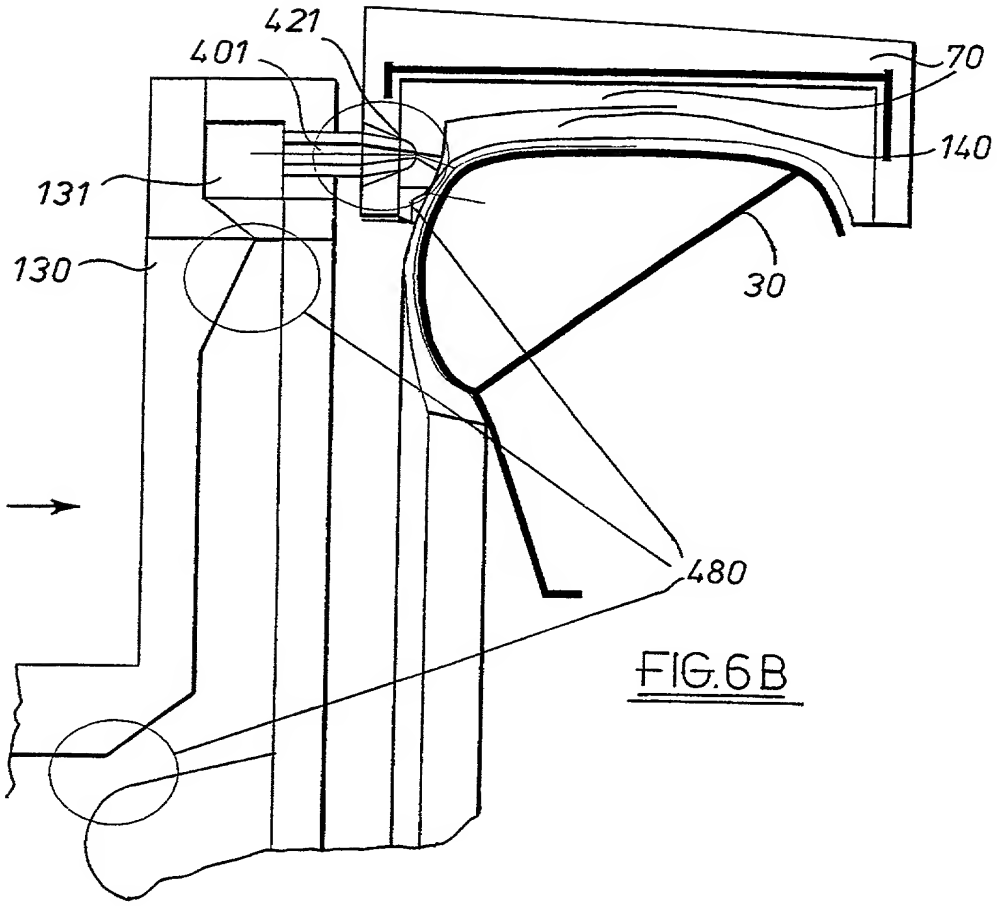
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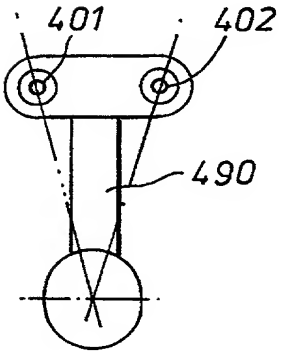
FIG.6B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402
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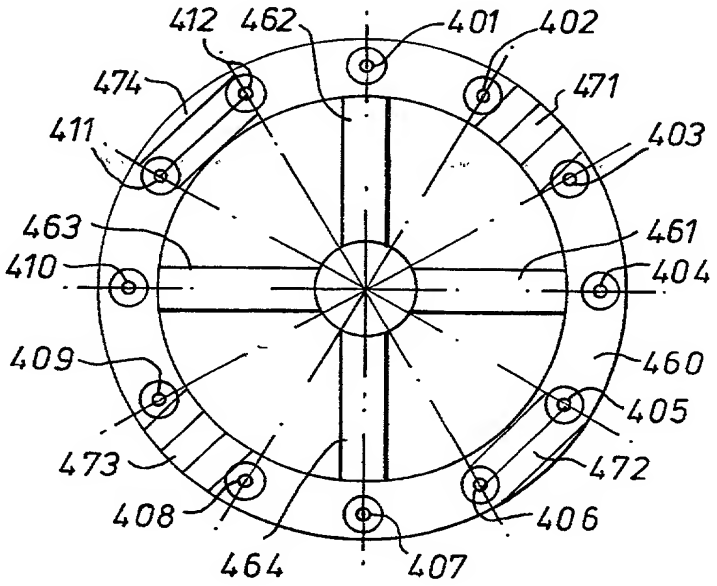
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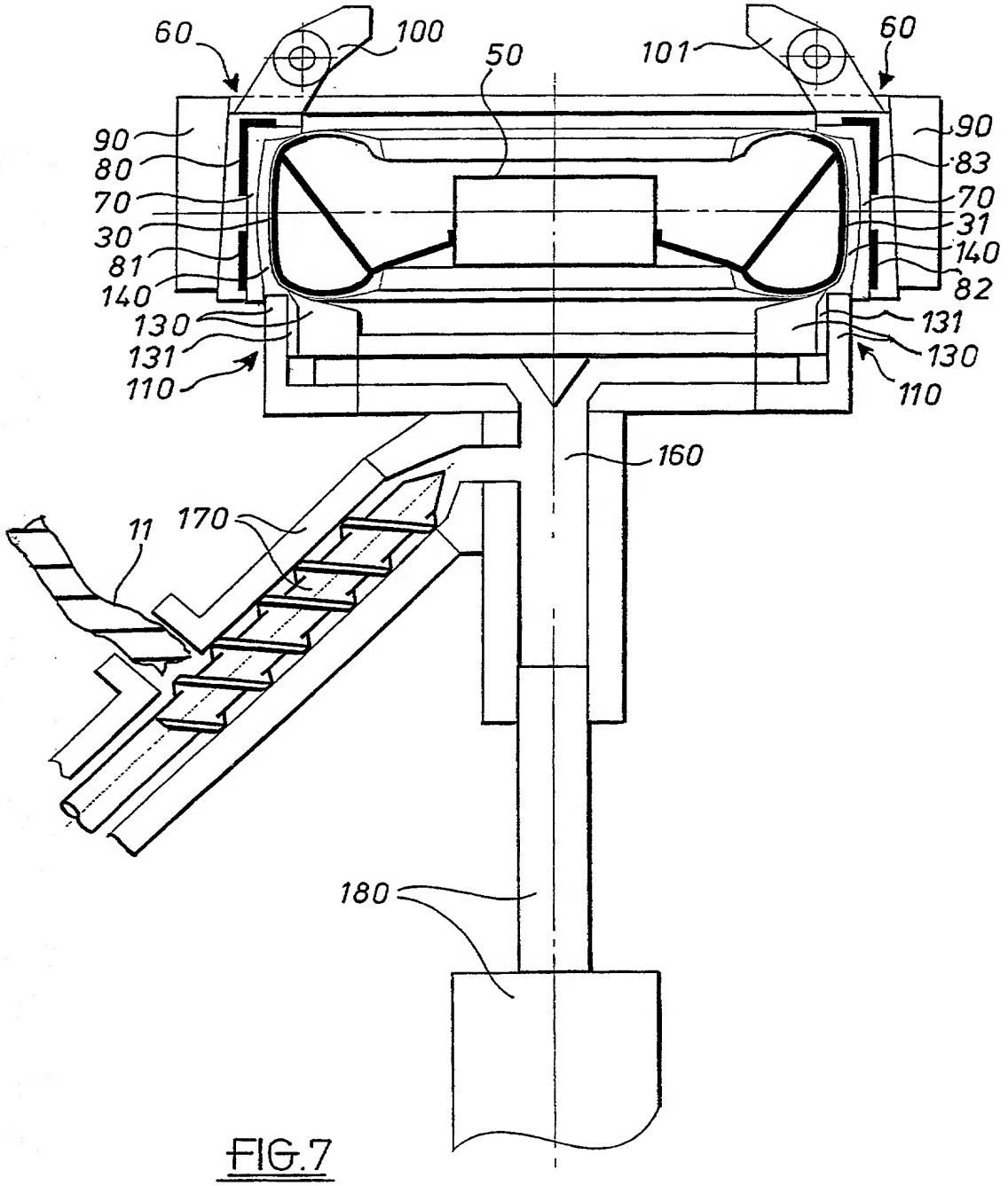
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FIG.7

MCNT 202 US

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My resident, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **"DIRECT TYRE RETREADING"**

( ) attached hereto.
(X) filed on Jan. 23, 2002 and assigned application Serial No. 10/048,237

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, 1.56(a).

Foreign Priority Applications

I hereby claim foreign priority benefits under Title 35, United States Code 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Priority Claimed

(Number)	(Country)	(Day/Month/Year Filed)	
99 173 64.3	Great Britain	24 July 1999	Yes (X) No ( )
			Yes ( ) No ( )

U.S. Priority Applications

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

PCT/GB00/02828	21 July 2000	Pending
(Serial No.)	(Filing Date)	(Status-patented/pending/abandoned)

Power of Attorney

I hereby appoint the following attorneys and patent agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: John E. Lynch, Reg. No. 20,940; Peter F. Felfe, Reg. No. 20,297; Norman D. Hanson, Reg. No. 30,946; John A. Bauer, Reg. No. 32,554; James R. Crawford, Reg. No. 39,155, C. Andrew Im, Reg. No. 40,657; and David Rubin, Reg. No. 40,314; my attorneys with full power of substitution and revocation. Address all telephone calls to **David Rubin (212) 318-3086**. Address all correspondence to:

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New York, New York 10103

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

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